Aldrovanda vesiculosa and its Cohabitant Algae in Culture

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Introduction

Carnivorous plants are usually weak competitors and are restricted to habitats that are unfavourable to noncarnivorous plants. The carnivorous aquatic species *Aldrovanda vesiculosa* L. (Droseraceae) seems in particular to have the least potential to compete successfully with other plants. Neither *Utricularia* nor other vascular hygrophytes (Juniper *et al.*, 1989; Adamec, 1997), or *Sphagnum* (Fijalkowski, 1958, cited in Juniper *et al.*, 1989) are usually tolerated, although exceptions are observed, such as recent observations of Aldrovanda in Western Australia with *Utricularia australis* (Gibson, 2004). In all cultivation protocols, even algae are considered to be a hazard for *Aldrovanda* (e.g. Adamec, 1997; Braem, 2002; D'Amato, 1998; Slack, 2000).

In the greenhouse at the Institute of Ecology and Conservation Biology in Vienna, we have cultivated *Aldrovanda* in numerous different pots indoor for over two years now. During our first experiments, we had immediate losses due to a heavy growth of algae but after the reduction of algae by *Typha*-extracts (Slack, 2000), we had better success. Finally, we were so successful that our plants flowered and fruited but to our great surprise, we observed thick mats of algae between these perfectly growing plants. Since this is contradictory to all literature on cultivation of *Aldrovanda*, a closer examination of these algae seemed appropriate.

Materials and Methods

Monitoring of algae in *Aldrovanda* cultivation pots was done during 2002-2004. Algal identifications were determined using Streble (2002), Migula (1907), Prescott (1978), Lenzenweger (1996; 1997; 1999), and Klotter (1970).

The thorough investigation of algae also revealed bacteria that apparently are tolerated by *Aldrovanda*. Analysis of bacteria was done by scanning electron microscopy and DAPI staining.

Microscopic investigations were done using Reichert Univar and Nikon Labophot II light microscopes and a Jeol JSM 35CF scanning electrone microscope.

Results and Conclusions

The analyses of algae resulted in the identification of twelve different genera of algae growing in the culture pots (Table 1). Of these, three genera occurred in combination with poorly growing plants. *Selenastrum* especially appears to be a real killer of *Aldrovanda*; after its mass development, our plants were dead within one week. Filamentous *Oedogonium* and unicellular *Characiopsis* (see Figure 1) grow as epiphytes (i.e. on the surface of the *Aldrovanda*) and kill *Aldrovanda* simply by overgrowing it.

The filamentous algae *Tribonema vulgare* (see Figure 2), *Oscillatoria* spp. and the coccal cyanobacterium *Gloeocapsa* were growing in very high abundance between flowering *Aldrovanda* plants, obviously doing no harm. In between the trichomes of *Tribonema*, six genera of unicellular, microscopic algae were found in low abundance (see Table 1, column 3), but these taxa were not restricted to well-growing plants. Sometimes we observed these species trapped and dead in the traps.

Bacteria were found in high abundance in all the pots used in our *Aldrovanda* cultivation:

Figure 1: *Characiopsis* sp. The unicellular alga is attached to an *Aldrovanda* trap by a disc-like rhizoid. Differential interference contrast image; scale bar indicates 20 microns.

Figure 2: The filaments of *Tribonema vulgare* can either be attached to *Aldrovanda* plants or occur free floating. Differential interference contrast image; scale bar indicates 20 microns.

On well-growing *Aldrovanda*	On poorly-growing *Aldrovanda*	Very rare or apparently uncorrelated to the health of *Aldrovanda*
Tribonemavulgare[1] (Tribonemataceae)	*Selenastrum* (Oocystaceae)	*Navicula* (Naviculaceae)
Gloeocapsa (Chroococaceae)	*Oedogonium*[1] (Oedogoniaceae)	*Closterium* (Desmidiaceae)
Oscillatoria (Oscillatoriaceae)	*Characiopsis*[1] (Characiopsaceae)	*Cosmarium* (Desmidiaceae)
		Chlorella (Oocystaceae)
		Gomphonema[1] (Gomphonemataceae)
		Dactylococcopsis (Chroococcaceae)

[1]Grows epiphytically.

Table 1: Genera of algae found with *Aldrovanda vesiculosa*.

in the water as well as between algae and on the surface of the water. Bacteria also grew epiphytically on the surface of the *Aldrovanda,* but in a much higher abundance on poorly growing individuals (see Figure 3). In all plants, bacteria were less frequent on the inner side of the trap than on the outside. We found a high abundance of protozoa in all pots and on all plants. *Paramecium caudatum* and *Zoothamnium arbusula* (see Figure 4) were the most common.

In contrast with most of the literature, we conclude that *Aldrovanda* is able to tolerate the presence of specific algae. Although some taxa are dangerous, others are completely harmless even after they grow into large masses. This is in agreement with the observations of Darnowski

Figure 3: Numerous bacteria around a quadrifid gland on the inner surface of an *Aldrovanda* trap. Scanning electron microscope image; scale bar indicates 20 microns.

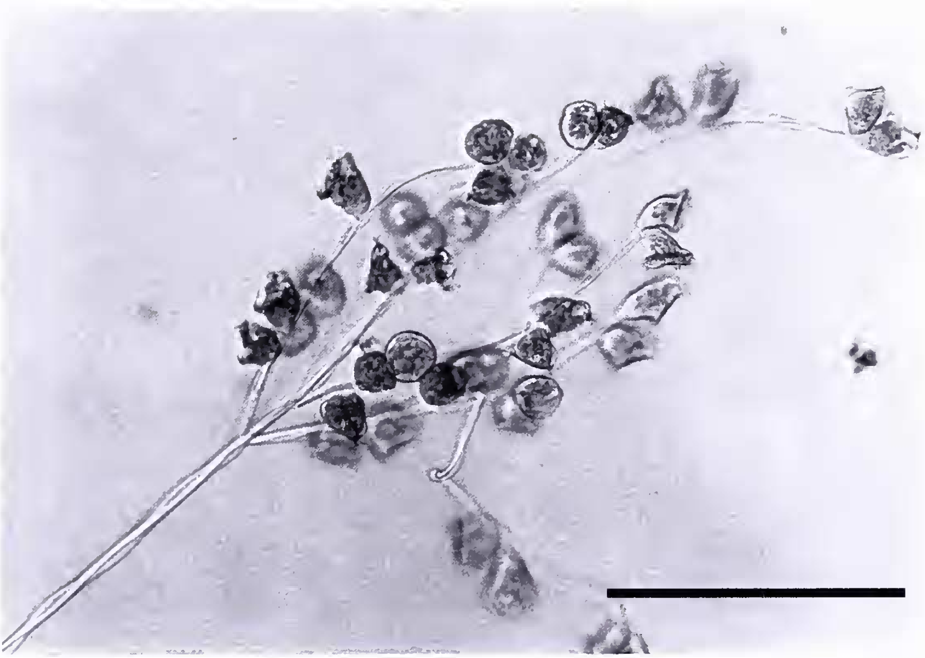

Figure 4: The sessile ciliate *Zoothamnium arbusculare* is often observed growing epiphytically on *Aldrovanda* plants. Bright field image; scale bar indicates 200 microns.

(2004) who found cyanobacteria and undetermined eukaryotic algae in *Aldrovanda* sites in Australia. All cyanobacteria occuring in our *Aldrovanda* pots are correlated with good growth and assimilating atmospheric nitrogen (Fogg *et al.*, 1973). The growth of *Aldrovanda* may be supported by this additional nutrient input. Bacteria do not appear to disturb the growth of *Aldrovanda*, but they are more associated with poorly growing plants. The presence of protozoa does not seem to affect the plants at all.

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News and Views

Dr. Thomas C. Gibson (tomgibson_5@hotmail.com) writes: Readers of Carnivorous Plant Newsletter might know that the Venus flytrap is now being considered for endangered status: about 70% of the populations monitored are now extinct and the last census found only an estimated maximum of 35,800 plants in nature. Decades of ruthless collection, as well as lack of fire and drainage of its habitat, have brought the flytrap close to extinction. (65,000 plants were dug each week from nature by one North Carolina Company alone in 1981). If you are interested in this conservation problem, what can one do? The safest place is preservation in nature, as agreed by most plant conservationists, and this means protection of its habitat, augmenting population sizes, and restoring most of the whole species. This is a costly and ambitious process. In essence, I propose a voluntary premium placed on each plant sold, perhaps 25-50 cents. This small added cost could generate $250,000 per year for restoration and conservation of this remarkable and unique carnivorous plant species. Such donated funds would be dispersed by an *ad hoc* Venus flytrap Conservation Committee, now forming. To learn about this, contact me for a summary of the proposal. What can you do as a reader of the Carnivorous Plant Newsletter? First, I would buy only genuinely propagated flytraps. You might donate to the fund, as instructed in the article. Just spreading the word alone might help immensely. With a small premium but big volume sold each year, the Venus flytrap can pay for its own conservation and be restored to its former glory where suitable habitat still exists.
Note: The ICPS is not affiliated with the organization mentioned in the above message.

Barry Rice (barry@sarracenia.com) writes: I have been studying a *Darlingtonia californica* site in Nevada County, California since 1997. This is the site famous for having the anthocyanin-free *Darlingtonia* 'Othello.' I have been very interested in the pollination biology of *Darlingtonia*, and those familiar with this topic know that despite many field studies, no one has ever identified the pollinator for *Darlingtonia*. It has been widely proposed that certain spiders are the pollinators. Like many other scientists who study *Darlingtonia*, I have never seen any pollination activity in *Darlingtonia* sites, despite having logged a great many hours in my research plots. However, on 21 June, on a trip to my research site to monitor this year's set of experiments on pollinator exclusion, I was astonished to see active pollination of the flowers by two species of bee. Extraordinarily, one of the bees was the non-native *Apis mellifera*, i.e. the common European honeybee. The second bee was a wild Californian species, *Andrena nigrihirta*. Stephen Davis was with me at the time, and together we observed as both species of bees repeatedly visited flowers, climbed up to the anthers, and subsequently left to visit other flowers. Obviously, the *Apis mellifera* cannot be considered part of the normal pollination biology of this plant, but the *Andrena* is apparently a pollination agent. A more detailed publication on this year's research is in development. You can see some of our preliminary results, including photographs of the pollinators, at: http://www.sarracenia.com/trips/ca012006.html